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New hybrids in *Dryopteris*

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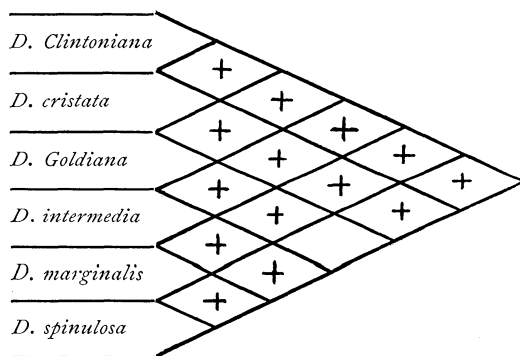
Fern students in the eastern United States can hardly expect to find new species in so well-known a region but the discovery that certain native species may hybridize, and that under favorable conditions they do so rather frequently, as in the case of *Dryopteris cristata* \times *marginalis*, opens up a field for study which is as yet very little known. There is always the chance that a new one may be found, and there are problems connected with the variation and the reproduction of the known hybrids which are yet to be worked out. The subject is not a simple one. Indeed a thorough knowledge of the plants can be obtained only after much experimental research and laboratory investigation, but field observers can render service by collecting these plants and recording the facts of their distribution, habit, and habitat. Furthermore, the intensive study needed in identifying the hybrids will add greatly to our knowledge of the parent species.

The hybrids so far reported for eastern United States number eleven and are comprised in three genera. *Asplenium* has two, *A. Ruta-muraria* \times *Trichomanes*, and the bigeneric hybrid *A. platyneuron* \times *Camptosorus rhizophyllus* (*Asplenium ebenoides* Scott). The latter is especially interesting as the first of our native hybrids to have its origin experimentally demonstrated.* The remaining hybrids are found in the genus *Dryopteris*, which, in this region, contains six species whose habitats are frequently associated, and which seem to hybridize more or less readily with each other. The species are *Dryopteris Clintoniana*, *D. cristata*, *D. Goldiana*, *D. intermedia*, *D. marginalis*, and *D. spinulosa*. Given six units, the number of possible combinations, taking two at a time, is fifteen, and we may expect to find that number of hybrids in this group. The following diagram, adapted from one used by Dr. Ezra Brainard in his studies of violet hybrids, shows

* Bull. Torrey Club 29 : 487-495. f. 1-7. 1902.

the present status of our knowledge of these plants. The known hybrids are marked with a cross.

The first of these to be described was *D. cristata* \times *spinulosa*, which has been recognized in Europe since 1855, but in America has only recently been differentiated by Dowell * from *D. cristata* \times *intermedia*, long known as *D. Boottii*. The first typically American hybrid to be described was Davenport's *D. cristata* \times *marginalis*, which had been discovered and recognized by Raynal Dodge.



Following this came the hybrid between *D. marginalis* and *D. spinulosa*, described as *D. pittsfordensis* by Miss Margaret Slosson, whose experimental production of the Dodge hybrid and of *Asplenium platyneuron* \times *Camptosorus rhizophyllus* has furnished a definite basis for a further study of these plants. Dr. Philip Dowell, the next in the field, besides recognizing *D. cristata* \times *spinulosa* as an American plant, gave *D. Boottii* its proper name (*cristata* \times *intermedia*), and described the corresponding *Clintoniana* cross, *D. Clintoniana* \times *intermedia*, and three interesting *Goldiana* hybrids.† In addition to these, the hybrids described in the present paper and one between *Clintoniana* and *marginalis* to be described by Miss Slosson, and two others which are held for further study, bring the number known in this group to fourteen, leaving only the one between *Goldiana* and *spinulosa* yet to be found.‡

But there is no apparent reason why hybrids should not occur

* Bull. Torrey Club 35: 135-140. 1908.

† Loc. cit.

‡ Since this was written, material has been seen which appears to be this hybrid, and a description of it is included below.

in genera other than *Dryopteris*. Indeed, several have been reported for *Asplenium*, principally in Europe, and in *Polystichum*, and we may expect such genera as *Athyrium* and others which contain groups of similar associated species to produce crosses when conditions are favorable.

The fern hybrids known at present are nearly all from temperate regions, but the damp forests of the tropics with their numerous related species and multitudes of individuals would seem to furnish ideal conditions for inter-specific crossing, and it is possible that many plants described as species are really hybrids. But as is noted hereafter, the determination of a hybrid requires a most thorough knowledge of the parent species and all their variations, not only in the herbarium but especially in the field, and until the intensive study necessary to the attainment of such knowledge can be given, the classification of the different forms as species is the only satisfactory method of treatment.

Fortunately for the study of our native hybrids, one of the commonest of them, *Dryopteris cristata* \times *marginalis*, has been experimentally produced, so that its origin is undeniable, and we are justified in assuming that plants which possess the same general characteristics and are similarly intermediate between two known species are also hybrids. A knowledge, therefore, of the general features of *D. cristata* \times *marginalis* is important in the study of other *Dryopteris* hybrids. These features may be considered under three heads: (1) intermediate character, (2) sterility, abnormality, and greater vigor, and (3) distribution.

1. The intermediate character of *D. cristata* \times *marginalis* led Dodge and Davenport to suspect its hybrid origin, but a study of numerous specimens of the hybrids shows that they are not all intermediate to the same extent. As one might expect, some plants show greater resemblance to one parent and some to the other. It is interesting to note also that an occasional reverting frond is found which resembles one parent much more than the other fronds on the same plant. In determining whether a suspected plant is intermediate or not, it is necessary to take into consideration several characters.

A. The general habit of growth often attracts the attention before the more easily described diagnostic characters can be seen

at all. This, of course, is likely to be especially marked if the parent species differ markedly in habit. But even in such cases one parent may predominate over the other to such an extent that the hybrid may be identified as one of the parent species.

B. The final tests depend then on an examination of the more critical characters and the value of these characters seems to vary inversely with the size of the part of the plant examined. For example, *D. Goldiana* and *D. Clintoniana*, which are often very similar in general leaf-form, differ in the shape and cutting of the pinnae and of the pinnulae, in the stipe-scales, and in the cell-structure of the indusia. The characters of the indusia have been very little used in fern classification, but they frequently furnish valuable tests in determining the identity of a given specimen, and are particularly useful in the class of ferns treated in this paper. *Dryopteris Goldiana* and *D. marginalis* have characteristic indusia, as can often be determined from a gross examination, and in cell-structure, these can easily be distinguished from the indusia of *D. Clintoniana* and *D. cristata*, and those of the spinulose ferns. The last-mentioned have indusia of the same general structure as have *D. Clintoniana* and *D. cristata*, but are much thinner, and in the case of *D. intermedia* are invariably glandular, a character which distinguishes this fern from all the other species of *Dryopteris* that occur in association with each other in this region. *D. dilatata*, which is occasionally glandular, is a fern of high altitudes in this latitude and need not be considered under ordinary circumstances, although where it does occur with other species, hybrids should be looked for. A hybrid between this fern and *D. Filix-mas* is already known in Europe. But aside from this possible exception, it seems safe to say that the presence of glandular indusia on a suspected plant indicates *D. intermedia* as one of the parent species. From what has been said, it will be seen that a primary requisite in the study of fern hybrids is a thorough knowledge of the parent species, not only of the general synoptical characters, but also of the more minute differences.

2. Sterility, greater vigor, and abnormality. The material of *D. cristata* \times *marginalis* and also of the other plants considered to be hybrids, is almost uniformly sterile. This sterility manifests itself either in the form of abortive undersized sporangia, or, if the

sporangia attain full size, in abnormal, granulated spores. Only in a few mounts out of scores examined have any normal spores been seen, and in these few instances their presence may have been accidental. But as in hybrids generally, it is probable that the sterility is relative rather than absolute, and we may expect occasionally to find fern hybrids capable of reproducing by spores.

Correlated with the sterility is usually a greater vegetative activity. This may be expressed merely in the development of larger plants, or it may take the form of abnormal fronds in which some parts are greatly expanded while others remain of ordinary size or even abort. Such irregular fronds are of frequent occurrence in *D. cristata* × *marginalis* but are by no means invariable, as many plants are found in which all the fronds are symmetrical. Occasionally this irregularity is so marked as to obscure the general resemblances of the suspected hybrid, and in such cases, unless the identity of the parent species can be established beyond doubt by means of critical characters, a positive identification may be impossible. In this connection it should also be noted that irregular plants which are to be explained as due to ecological conditions or as sports rather than as hybrids, are not unusual.

3. In distribution, *Dryopteris* hybrids are rare or occasional in damp woods with the parent species. The general occurrence of hybrids has been doubted because of the presumed difficulty of the actual process of hybridization but the presence of numerous plants of *D. cristata* × *marginalis* in some especially favored localities is evidence that the difficulty may not be as great as has been imagined. The immediate presence of the parent species is not a necessity since fern plants are often long-lived and the greater vigor of the crosses might render them resistant to conditions sufficiently adverse to destroy the parent species.

Following are descriptions of hybrids already noted as new :

***Dryopteris Clintoniana* × *spinulosa* hyb. nov.**

In habit resembling *D. Clintoniana*, the rootstock horizontal, the fronds of two sorts : (1) juvenile and sterile, and (2) mature and usually soriferous : mature fronds tall, about 70 cm. long ; stipe light yellow above, dark brown below, clothed with thin pale brown scales ; lamina oblong, acuminate, 30-40 cm. long, by 16-20 cm. broad, once pinnate, the rachis distinctly winged in the upper fourth ;

pinnae oblong and sessile above, to deltoid and stipitate below (lowest pinnae 7–10 cm. long by 4–6.5 cm. broad), mostly deeply pinnatifid half way to the midveins or more except in upper fourth of the lamina, nearly pinnate below but with winged midveins; pinnulae oblong to oblong-lanceolate, straight or slightly falcate, somewhat acuminate, up to 4 cm. long by 1.6 cm. broad, entire, spinulose-dentate or pinnatifid (half way to midveins on basal pinnae), bases unconstricted above (upper third of lamina), to deeply constricted below (nearly to the midvein in basal pinnae), the lobes and teeth mostly inflexed: sori rather scant, midway between the margins and the midveins; indusia thin, glabrous: juvenile fronds low-spreading, the laminae oblong, about half as broad as long.

Type in the Underwood Fern Herbarium, New York Botanical Garden: *Benedict 68*, from Cornwall, Conn., July, 1907. Collected also by E. Brainerd at Middlebury, Vt., June, 1879, and July, 1908; by E. J. Winslow at Barton Landing, Vt., Aug. 16, 1908; and by Ph. Dowell 3928 (in part), at Suffern, N. Y., July 23, 1905.

As might be expected, this fern resembles *D. Clintoniana* × *intermedia* rather closely, but its relationship to *D. spinulosa* is shown not only in the glabrous indusia but also in the general habit and cutting of the fronds. From *D. cristata* × *spinulosa*, it differs usually in size and shape of the fronds, but even more decidedly in the amount of cutting.

Dr. Ezra Brainerd's early collection of this hybrid is of especial interest in view of the fact that as a rule the earlier collectors apparently paid little attention to these plants and either overlooked them or were satisfied to refer them to some previously described species. Fern hybrids had been recognized in Europe as early as the '50's, but in America little was done with them until near the close of the century. It is to be noted here that two specimens of what we now know to be a hybrid between *Dryopteris cristata* and *D. marginalis* were identified by the dean of American fern study, Professor Daniel C. Eaton, as his *Aspidium cristatum* var. *Clintonianum*, as can be seen in his herbarium today. The original collection of Judge Clinton is not represented in the Eaton herbarium but according to the late G. E. Davenport in a letter to Miss Margaret Slosson, it is represented in the Museum of Natural Science at Springfield, Massachusetts. As a small photograph of this Springfield material shows it to be somewhat different from

what to-day is ordinarily known [as *Dryopteris Clintoniana*, an inquiry as to the exact identity of the type of this species is much to be desired.

***Dryopteris cristata* × *Goldiana* hyb. nov.**

Fertile fronds tall, up to 120 cm. ; stipe pale, clothed with dark scales; lamina narrowly elliptic-lanceolate, acuminate, up to 73 cm. long, 18 cm. broad, once pinnate; pinnae lanceolate above, oblong-lanceolate in the median portion, and deltoid-ovate below, long-acute or slightly acuminate, short-stipitate except in the upper part of the frond, nearly pinnate; pinnulae 12–14 pairs on the median pinnae, oblong, acute or acutish, entire or slightly crenate-serrulate, the costal pinnulae constricted on both sides, the remainder merely notched above or wholly adnate: sori 6–8 on the larger pinnulae, nearer the midvein than the margin; indusia rather thin, glabrous, the cells about as broad as long and in fairly regular radial rows, the walls rather thin, straight or only slightly sinuate.

Type in the Underwood Fern Herbarium, New York Botanical Garden, *W. A. Poyser*, Swarthmore, Pa., June 20, 1908. Also 309 *A* and *B* from the same locality and collector, July 15, 1906.

The critical characters on which the identification of this fern is based are, on the one hand, the cell-structure of the indusium, which shows its relationship to *D. Goldiana*, and on the other, its slender outline and broad lower pinnae, which relate it to *D. cristata*. But it shows its relationship to both parents, and is intermediate between them in its stipe-scales, in the shape of the pinnae, in the shape and number of the pinnulae, and in the number and position of sori on each. The type specimen was originally identified by Mr. Poyser as "*Dryopteris Clintoniana* (Eat.) approaching v. *silvatica*," but it differs from this fern in about the same degree that *D. cristata* differs from *D. spinulosa*. The sporangia are all abortive.

***Dryopteris Goldiana* × *spinulosa* hyb. nov.**

Nephrodium cristatum Clintonianum f. *silvaticum* Poyser, Fern Bull. 16: 13. [Mr] 1908.

Fronds up to 110 cm. long; stipes pale yellowish, clothed at the base with dark lanceolate scales; lamina elliptic or elliptic-lanceolate, 75 cm. long, 27 cm. broad, very nearly twice pinnate; pinnae mostly oblique to the rachis, varying from oblong-lanceolate in the upper portion of the frond to elliptic-lanceolate or

elliptic in the median portion, and to unequally ovate-lanceolate below, acuminate, stipitate nearly to the apex of the frond ; pinnae about 12–16 pairs on the larger pinnae, narrowly oblong or lanceolate, long-acute, up to 4.5 cm. long, and 1.5 cm. broad, varying from constricted on both sides and serrate-lobed on one third to one half of the larger pinnae to wholly adnate and merely serrulate above, the lobes spinulose-serrulate : sori about 8–10 pairs, about midway between the midveins and margins ; indusia glabrous, thin, the cells about as broad as long and in fairly regular radial rows, the walls rather thin, straight or only slightly sinuate.

A year ago when I first saw a specimen of this fern I was inclined to identify it as *D. Clintoniana* \times *spinulosa*, assuming that Mr. Poyser had properly related it to the Clinton fern. Afterwards, however, I collected what is certainly *D. Clintoniana* \times *spinulosa*, and had to give up this identification for Mr. Poyser's plant. My first valid clue to its identity came when I took occasion to examine the indusia under the microscope and found in them a strong resemblance to the *D. Goldiana* indusia, and corresponding differences from the indusia of the Clinton fern ; even then I did not immediately correctly determine the other parent but, having at that time only a narrow frond of f. *silvatica*, referred it to *D. cristata* \times *Goldiana*. Recently, however, Mr. Poyser has loaned me all his material, comprising several fronds, all of which have unmistakable *spinulosa* characters in the amount of cutting, in the unequally ovate-lanceolate lower pinnae, and in the oblique habit of nearly all the pinnae, and in the position of the sori. The relationship to Goldie's fern appears in the size and habit of the whole plant, the pinnae widest above the base, as is shown in the original illustration, the numerous pinnulae, together with the shape of the latter and the number of sori on each, and particularly in the structure of the indusia. The last-mentioned characters, with the exception of size, also serve to distinguish *D. Goldiana* \times *spinulosa* from *D. Clintoniana*. The material was collected rather too early to allow the question of fertility to be certainly ascertained, but the indications are that the sporangia had aborted.

***Dryopteris intermedia* \times *marginalis* hyb. nov.**

Rootstock erect or ascending : fronds in a symmetrical crown, spreading, the stipes thickly clothed at base with lanceolate

scales; laminae lanceolate, elliptical or oblong, acuminate, bipinnate or nearly tripinnate; pinnae lanceolate or oblong-lanceolate to narrowly deltoid, acuminate, rather flexuose, pinnate below; pinnulae oblong or lanceolate, usually blunt and rounded, entire to deeply pinnatifid or sometimes nearly pinnate on the lowest pinnae, the margins entire or dentate, the teeth blunt, entire or tipped with a few very short patent spinules: sori nearer the margins than midveins, the indusia coriaceous, convex, glandular.

Type in the Underwood Fern Herbarium, New York Botanical Garden; *Benedict*, near Solvay, N. Y., Aug. 9, 1905. Also collected by Underwood near Cambridge, Mass., Oct. 11, 1890; *Dowell* 3622, New Springville, Staten Island, N. Y., Nov. 27, 1904; and *Winslow*, Barton Landing, Vt., July 23, 1908.

D. intermedia \times *marginalis*, as represented in the material examined, constitutes a very uniformly distinctive plant, which differs from the nearly related \times *D. pittsfordensis* * in its obtuse pinnulae and segments, in its spreading flexuose pinnae, and in its glandular indusia. The material collected by Professor Underwood is more divided than the rest and in this respect perhaps shows a greater predominance of *D. intermedia* characters. In Dr. Dowell's collection cited above, some of the pinnulae are more or less acute, but the variation is slight. The hybrid is one of the most easily recognized in the whole series.

In conclusion, I wish to express my thanks to Dr. Ezra Brainerd, Dr. Philip Dowell, Mr. W. A. Poyser, and Mr. E. J. Winslow, for the loan of material.

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* *Dryopteris pittsfordensis* Slosson, *Rhodora* 6: 75. 1904 = *Dryopteris marginalis* \times *spinulosa* Slosson, nom. nov. The formal publication of this name is made here for the sake of convenience, as no authority has ever been assigned to the name, although Miss Slosson clearly should be considered responsible for it.